The problems of living in the sea: the uptake of inorganic carbon and nutrients in *Posidonia oceanica* (L.) Delile.

Lourdes Rubio, Delia García-Pérez, María Jesús García-Sánchez and José Antonio Fernández
Dpto. Biología Vegetal. Facultad de Ciencias. Universidad de Málaga. Campus de Teatinos s/n. 29071 Málaga (Spain)
JA_fernandez@uma.es

The genus *Posidonia* exhibits a peculiar geographical distribution. It is composed by nine species, eight of which are distributed along the Australian coasts and only one, *Posidonia oceanica* (L.) Delile, is a Mediterranean endemism. Like other angiosperms, *P. oceanica* has adapted secondarily to the marine environment, and has developed anew mechanisms to face a liquid and alkaline medium (pH 8.2) that contains a high salt concentration (0.5 M NaCl). The liquid environment limits the diffusive flow of CO_2 and nutrients and, furthermore, CO_2 dissolves in water and forms HCO_3^-, the more abundant chemical species of inorganic carbon at pH 8.2.
Like other green plants *P. oceanica* uses CO_2 for photosynthesis. In addition, this species shows a transport system in the plasma membrane for the direct uptake of HCO_3^-, that uses H^+ as the driving ion. The addition of HCO_3^- provokes a transient hyperpolarization of the plasma membrane followed by a depolarization; at the same time, the cytosolic pH (pH_c) becomes transiently acidic and next it gets alkaline, and remains alkaline throughout the HCO_3^- pulse. The alkalinization of the pH_c is due to the cytosolic accumulation of HCO_3^- and OH^- and it is sensitive to the addition of ethoxyzolamide, an inhibitor of the internal carbonic anhydrase. The increase of negative charges in the cytosol triggers the release of Cl^- to recover the values of the resting membrane potential. The plasmalemma of *P. oceanica* exhibits a reduced Na^+ permeability and shows a H^+/Na^+ antiporter activity that keeps low and relatively constant the cytosolic Na^+ concentration (17 mM Na^+). The inside negative membrane potential (-178 mV) and the low $[Na^+]_c$ generate a tremendous Na^+-motive force that this plant uses for the high affinity transport of NO_3^- (Km= 21 μM), and of the amino acids alanine (Km= 37 μM) and cysteine (Km= 10 μM). The uptake of these compounds shows a strict dependence on the presence of Na^+ in the medium. Moreover, the addition of micromolar concentrations of NO_3^-, alanine or cysteine gives rise to millimolar increments of $[Na^+]_c$. Experiments with external LIX pH mini-electrodes show that the uptake of glucose is not Na^+ but H^+ dependent. Thus, the model for the ion transport energization in this species seems to be mixed, with a H^+-ATPase as the primary pump and a series of carriers that use H^+ (HCO_3^-, Na^+, glucose) or Na^+ (NO_3^-, amino acids) as the driving ion.

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